Standard Operating Procedure (SOP)

Durham Magneto Optics MicroWriter ML3 Pro (LW-03)

In case of fire or injury please call 911 (511 from campus phones)
In case of chemical spill, contact EHRS at 215-898-4453

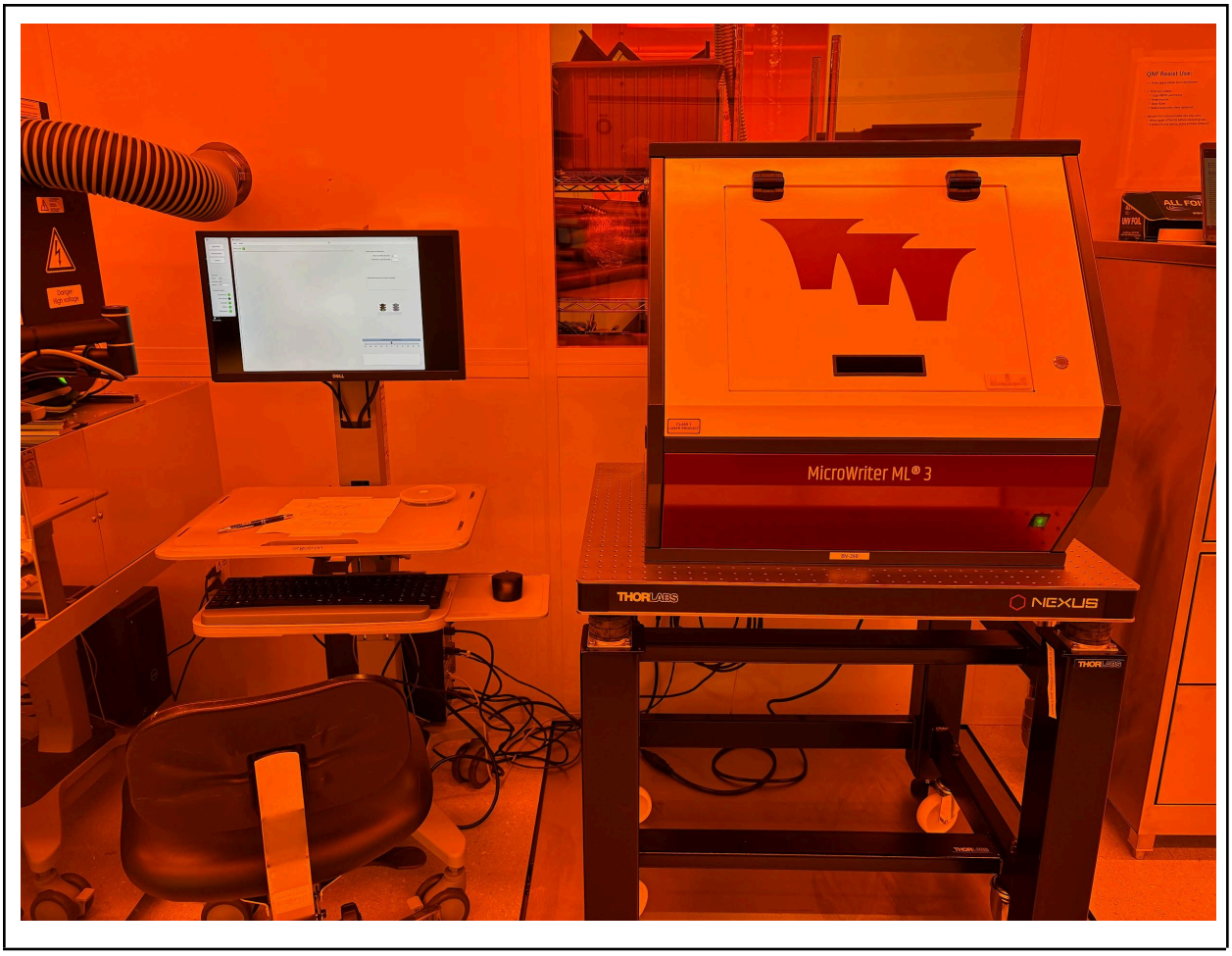
If there is an error on the system/tool please report it in NEMO, the staff will take care of it

Please *DO NOT* run diagnosis or attempt to perform equipment maintenance or repairs without a staff member's approval

General safety tips and common mistakes

- If the software is closed on the computer, ensure that the tool is powered on (green button) before opening the MW3 software
- If the software becomes unresponsive or crashes, force close the software and re-open from the desktop
- Excessively long exposure times can be caused by pattern resolution and/or focus lock options. Check the parameters in the appropriate locations for troubleshooting
- Windows login account password is: Micro3Writer

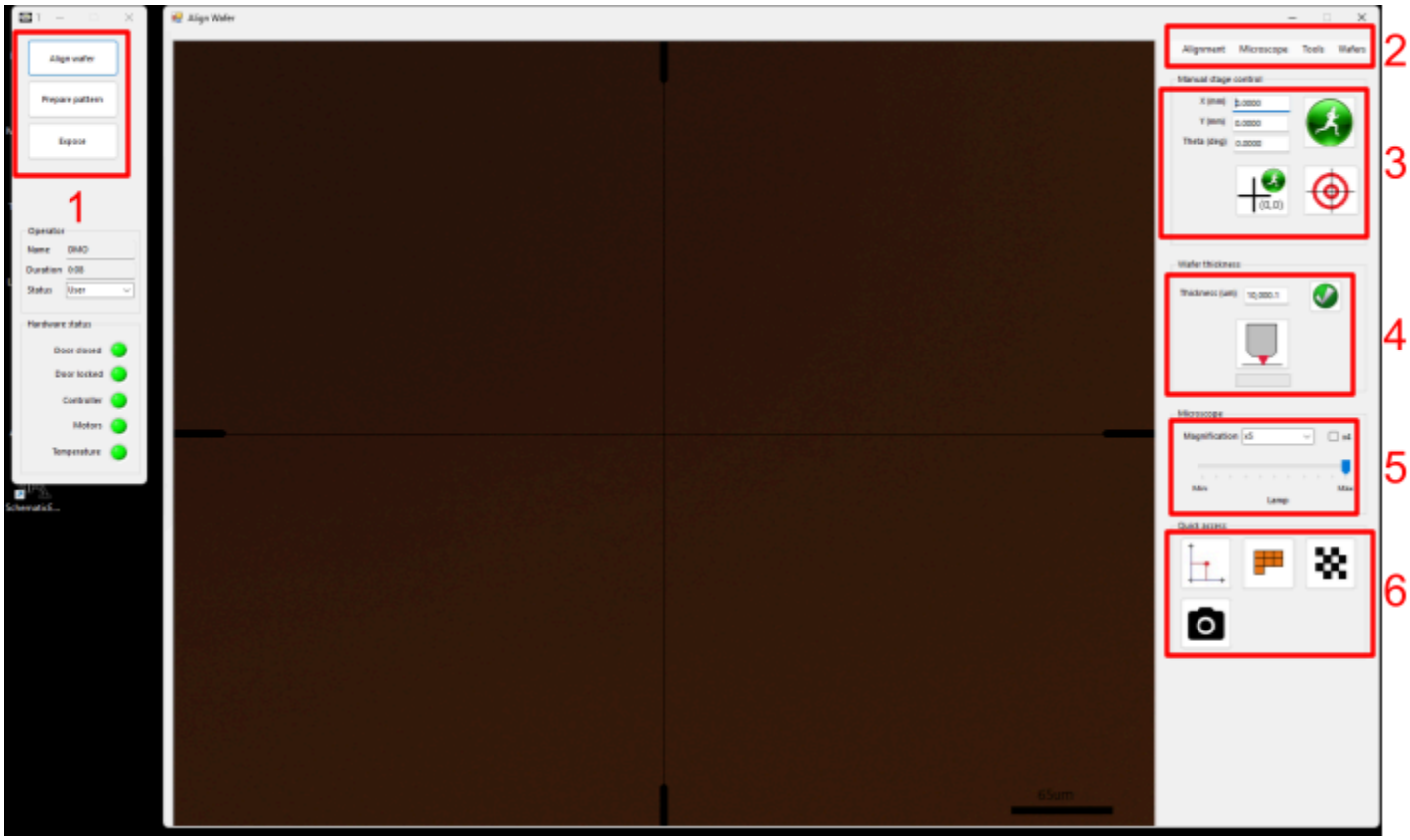
Created by Dan Sabrsula, 08/07/2025
Last modified by Dan Sabrsula, 09/24/2025



Summary

The ML3 Pro is a flexible direct-write lithography tool with two laser sources at 405 nm and 365 nm and a minimum feature size of 400 nm. It is capable of exposing across multiple samples during a single exposure, as well as changing resolution mid-exposure. The DMO MW3 software can render and expose standard .GDS files with little to no file preparation, as well as non-standard file formats such as .PNG, .DXF, .CIF, .BMP.

Software Overview:



1. Window navigation
2. Wafer properties and system tools
3. Stage movement and automatic feature centering
4. Sample height and autofocus
5. Change objective, digital zoom, and lamp intensity
6. Alignment, wide-field view, checkerboard, capture image

Procedure Overview

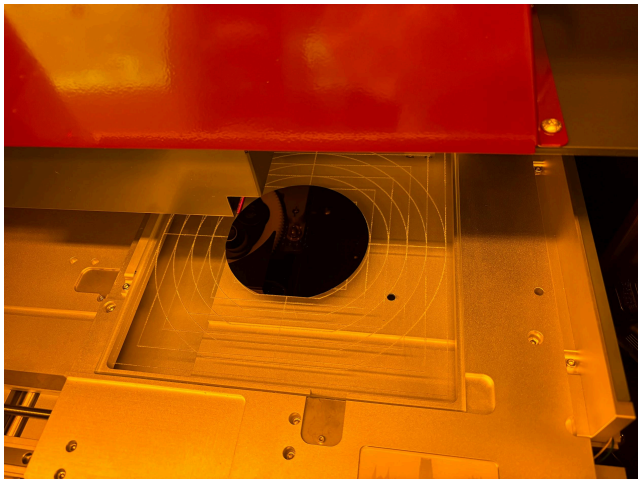
1. Login on NEMO
2. Load Sample
3. Alignment
4. Prepare Pattern
5. Expose
6. Unload Sample
7. Log out from NEMO

Full Procedure

1. Login: 1.1. Log in to LW-03 on NEMO 1.2. Confirm that the MW3 software is open on the computer. If it is closed, click on the DMO shortcut on the desktop to launch the software and wait for it to fully load	
2. Load Sample: 2.1. Press the button next to the lid to move the stage into the load position and unlock the door 2.1.1. The red light indicates what state the tool is in; solid red = stage at working position and lid locked, light off = stage at load position and lid unlocked, flashing light = stage in motion 2.1.2. If the software is not open, the lid button will be unresponsive	

2.2. When the light on the button turns off, you may open the lid all the way and carefully place your sample(s) face-up on the glass plate

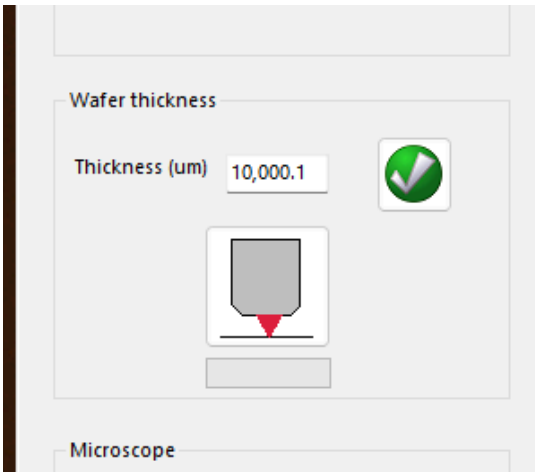
2.2.1. Centering your sample on the plate can help when navigating/aligning to your sample, but is not critical



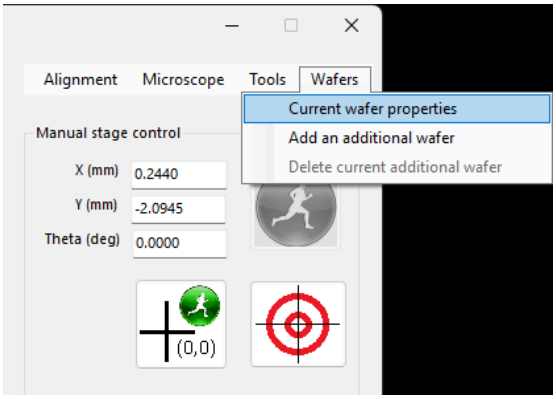
2.3. Close the lid and press the button to lock the lid and move the stage into the working position

2.4. On the right side of the “Align Wafer” screen, enter an estimate for the thickness of your sample and hit Enter to move the stage height, then click the icon to perform an auto focus

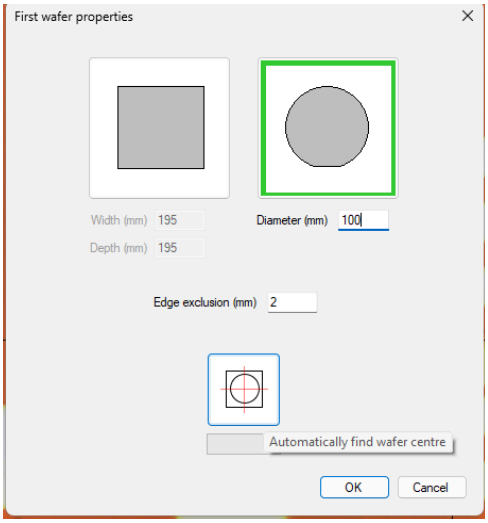
2.4.1. **Note:** If you do not change the height before performing an auto focus, the tool will scan the entire range of motion of the z-axis in steps of 50um before it finds your sample. To stop an auto focus in progress, you can click the icon again



2.5. Once your sample is in focus, you may choose to center your sample by going to the “Wafer” dropdown menu on the top right, select “Current Wafer Properties”, select the appropriate shape of your sample and enter the correct dimensions. To start the centering, click the “cross” icon and wait for the process to complete



2.6. When the centering is complete, you may close the wafer property window. The origin for the coordinate system in the software will now be updated to the geometric center of your sample, rather than the center of the stage

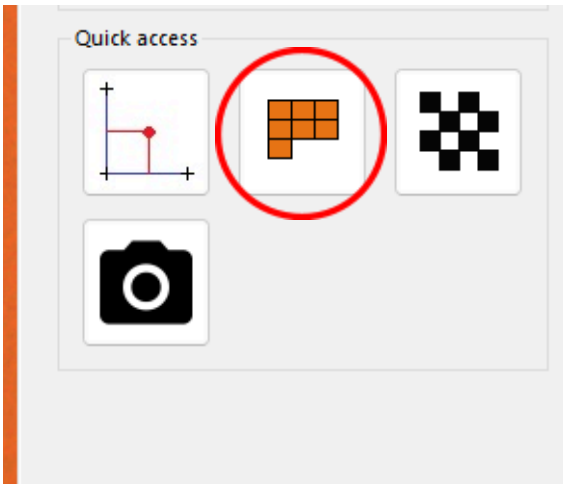


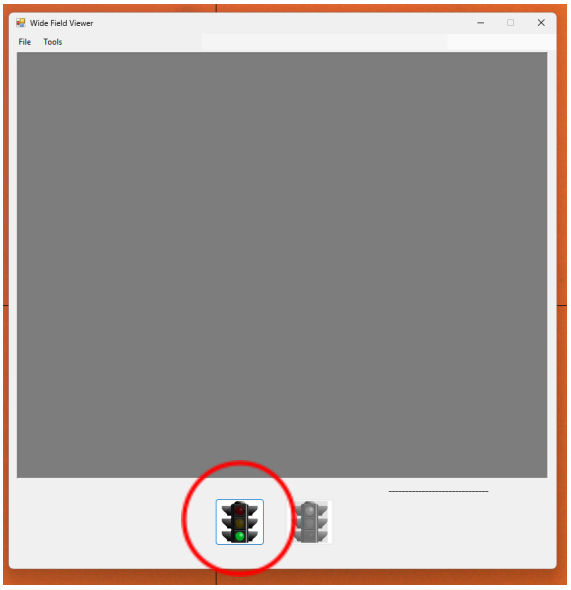
3. Alignment (optional):

3.1. With your sample in view, you may move from the origin to any features on your sample that you wish to align with

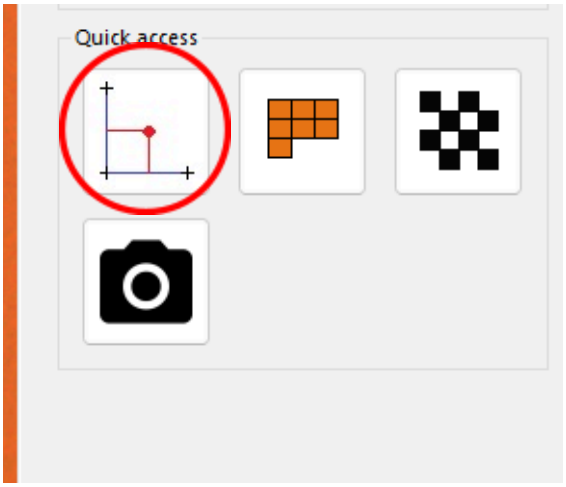
3.1.1. To drive the stage, you can double-click on the camera view to move to the location of the cursor, or you can click and drag in the direction you want to move relative to the center of the camera. If you know the exact coordinates of your features, you may also input them into the X and Y values and press the green running icon to move to the desired location

3.1.2. Alternatively, you can choose to generate a tile image from your current location to make a map of the surrounding features. Click the “Tile” icon and click the green light to start collecting images. Once you are satisfied with the mosaic, click the red light to stop. You may now double-click on any point within the tiled image to drive that point



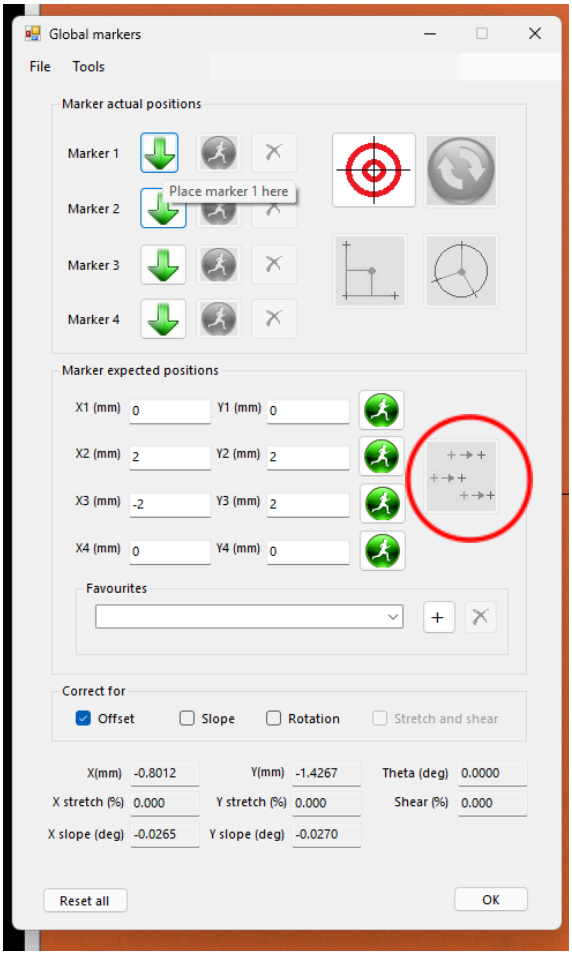


3.2. Locate your first alignment mark and open the alignment window by clicking the “Coordinate” icon



3.3. Move the camera so that the center of the cross on the screen is at the correct location for aligning

3.4. In the alignment window, click the green down arrow at the top of the list to pin your first alignment mark, and enter the exact X and Y coordinates from your pattern file



3.5. With the alignment window open, repeat the previous 3 steps for up to 4 total alignment marks

3.5.1. As you add more alignment marks, you can choose to correct for additional factors by selecting from the options listed in the “Correct for” section of the Global markers window

3.6. Once you are done aligning, click the “Transform Coordinates” icon in the alignment window to calculate the new coordinate system according to the information entered for the alignment marks

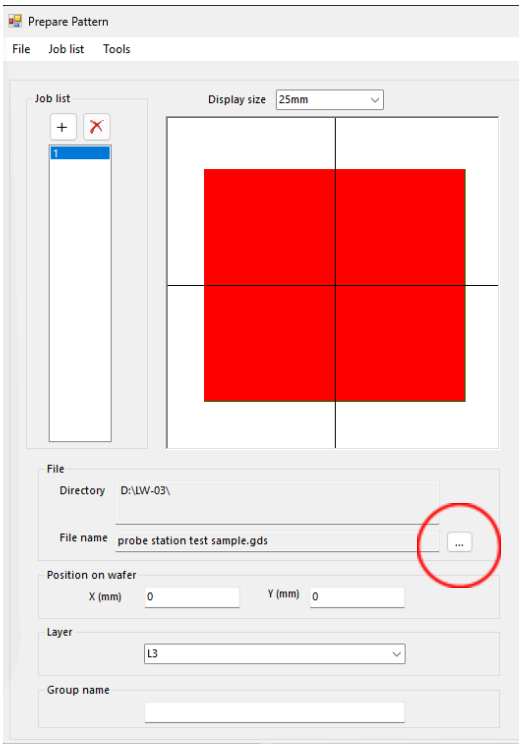
4. Prepare Pattern:

4.1. Move to the “Prepare Pattern” screen to begin building your job list

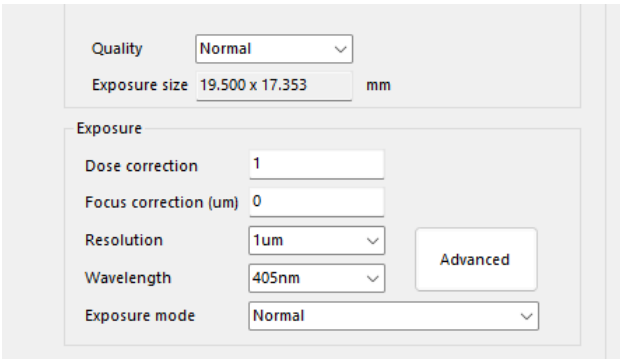
4.2. To expose a single layer/pattern, click the “Plus” icon below the job list text to add a new job

4.2.1. If there is data left behind by the previous user, you can right click on the job list, hit select all, and delete by clicking the red X at the top of the list

4.3. With job number 1 selected, click on the three dots next to the “File name” field to load your pattern file



4.4. Once your file is loaded, you can make the appropriate changes to the exposure including: objective resolution, wavelength, position on wafer, and specific layer to expose



4.4.1. If exposing on multiple samples, you can assign a selected pattern to a given wafer by typing in the wafer name in the “Group name” field at the bottom of the prepare pattern screen

4.5. To run a dose-focus array, open the “Job List Builder” from the Tools dropdown tab

4.6. Choose a pattern to array by clicking the three dots and loading your pattern file

4.7. Select the area to fill, and define the size of the array in millimeters

4.8. Enter the center-to-center distance for each pattern in X and Y in millimeters

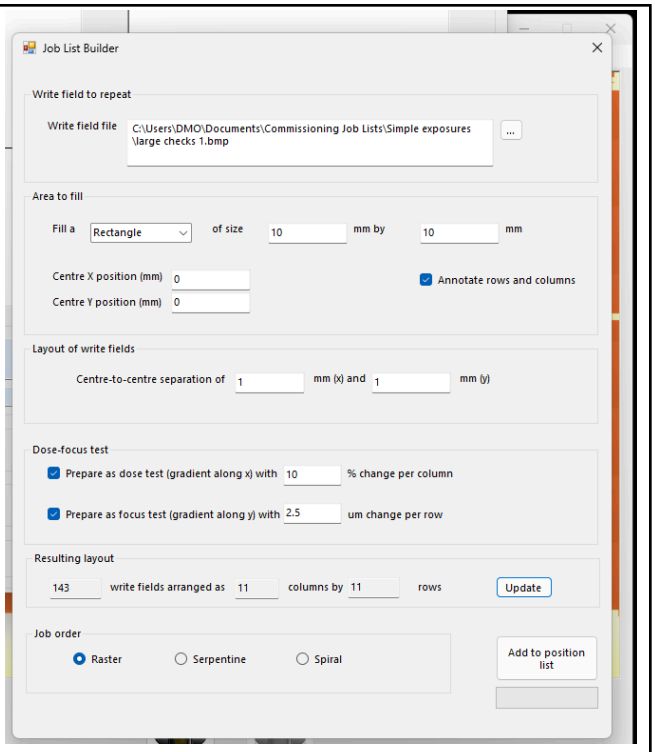
4.9. Select the options to “Prepare as dose test” and “Prepare as focus test” to vary the dose and focus across the array

4.9.1. The origin of the dose/focus array will be the center pattern. Dose and focus gradients will vary from low to high across the X and Y axes respectively

4.10. With the array parameters entered, click the “Update” button to generate the number of rows and columns. Once updated, click “Add to position list” to populate the job list with the array

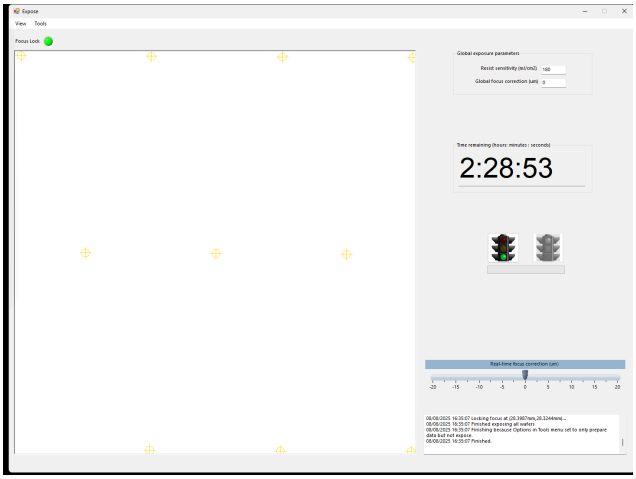
4.11. You may review each pattern by clicking on the job number or by selecting a box from the display

4.12. To change the source wavelength or resolution, you can select all jobs by right-clicking on the list to select all, and changing the common parameters



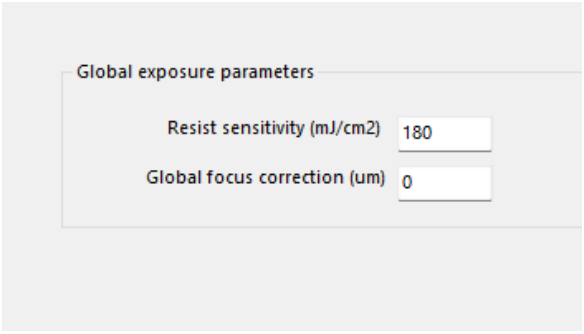
5. Expose:

5.1. Once your pattern is ready, move to the “Expose” window



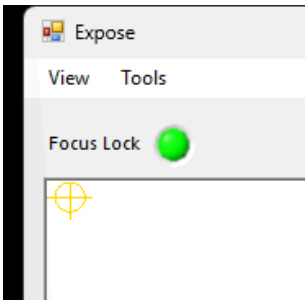
5.2. In the top right of the Expose window, you can set the global dose and focus correction values used for all exposures

5.2.1. When writing a dose-focus array, the global exposure parameters are used for the parameters of your center pattern



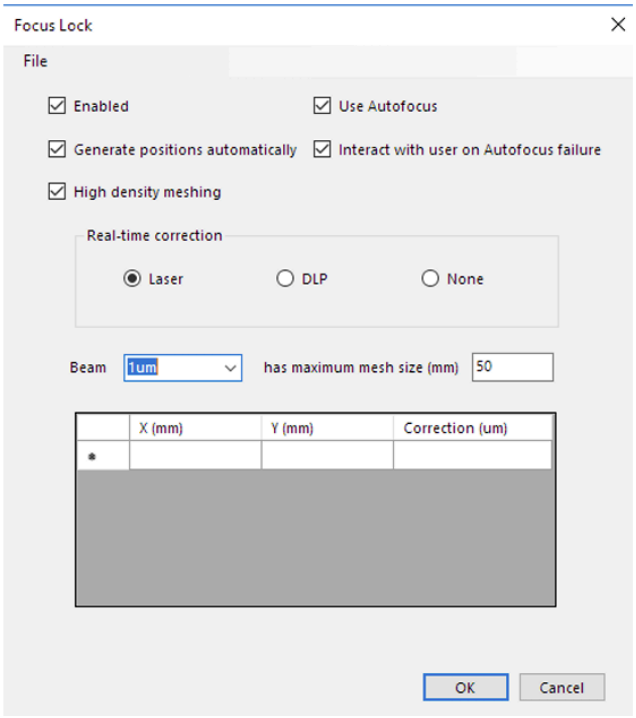
5.3. To estimate the total time of your exposure, click the “Start rendering” option from the Tools dropdown menu. The time remaining will update to show your total exposure time

5.3.1. Unusually long exposure times may be caused by the “Focus Lock” parameters. To check, open the Focus lock options from the Tools dropdown menu.



5.3.2. You may change the parameters to decrease the number of focus lock positions by unselecting “High density meshing” and/or unselecting “Generate positions automatically” and manually entering the XY coordinates for focus lock points. Alternatively, you may choose to disable the focus lock altogether, which will skip the focus step and expose your full wafer at a constant thickness.

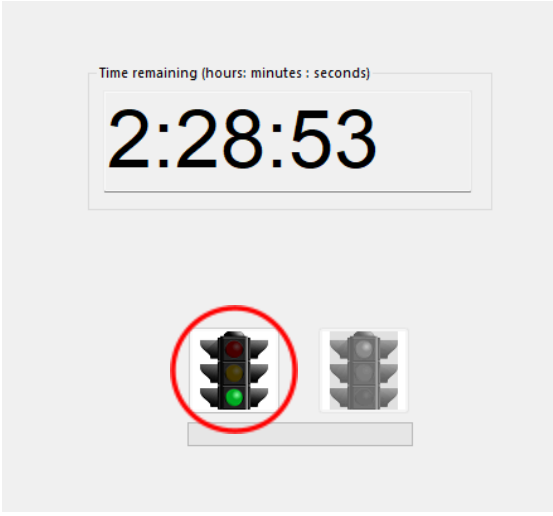
5.3.3. You may re-render your exposure to see if the changes result in a shorter exposure time



5.4. Once you are ready to expose, simply click on the green light icon to start running your job

5.4.1. If you did not perform an autofocus when loading in your sample, the software will ask if you would like to continue without running autofocus before the exposure begins

5.5. Once the timer reaches 0:00:00, the exposure will be complete, and a “Finished” message will pop up in the exposure log in the bottom right corner of the Expose window



6. Unload Sample: 6.1. When your exposure is finished, you may press the button next to the lid to move the stage back to the load position 6.2. Take your sample out, and close the lid	
7. Log out: 7.1. Log out of LW-03 on NEMO	